CEMENT AND LIME MANUFACTURE

691

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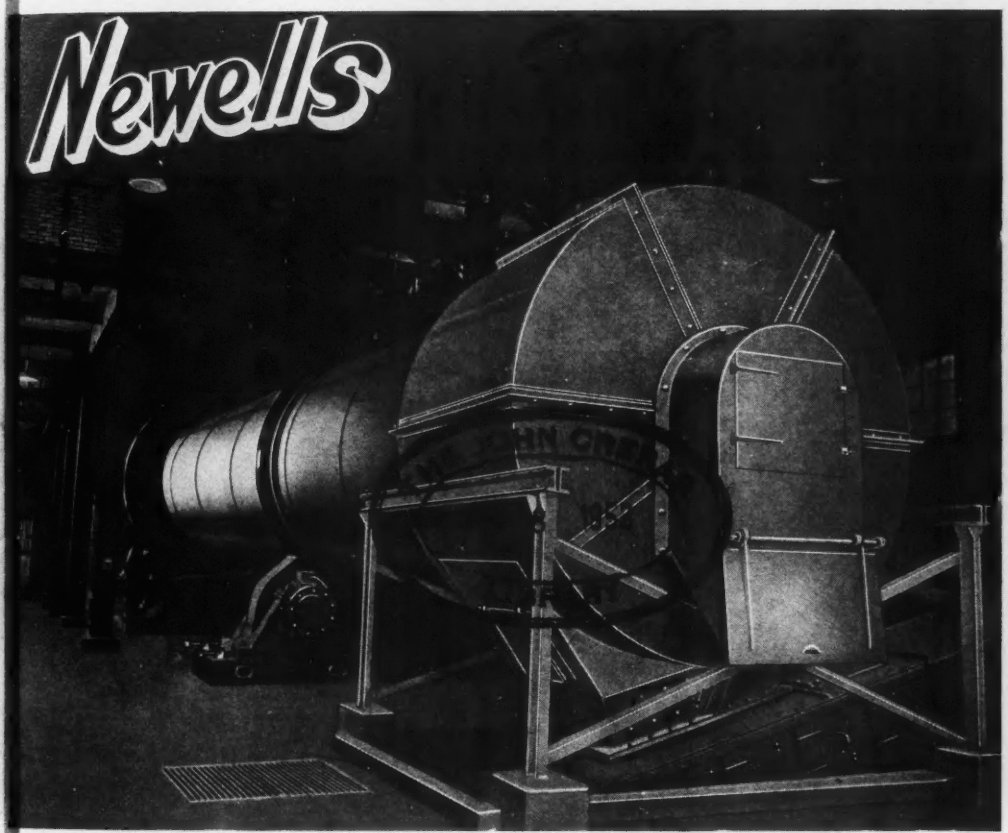

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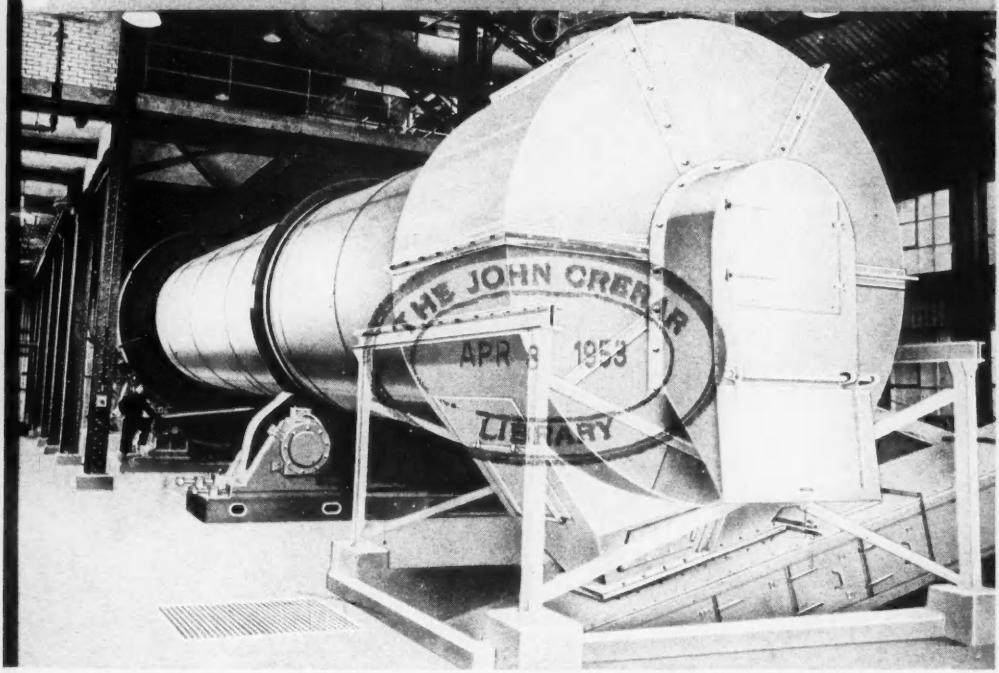

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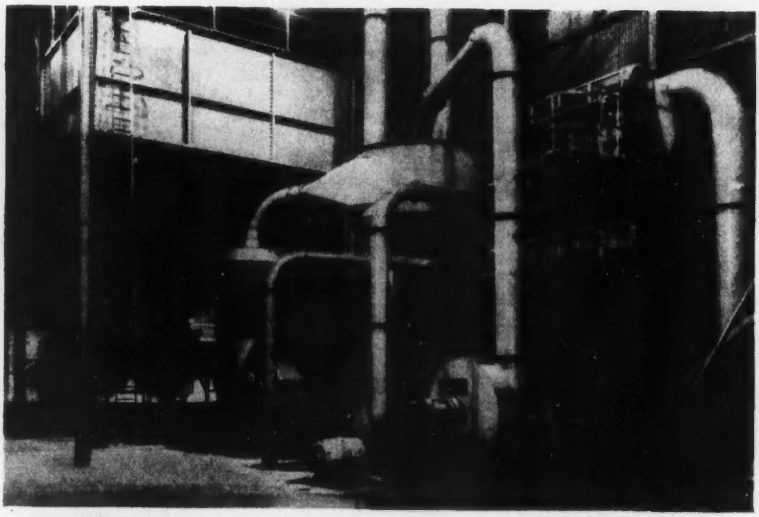

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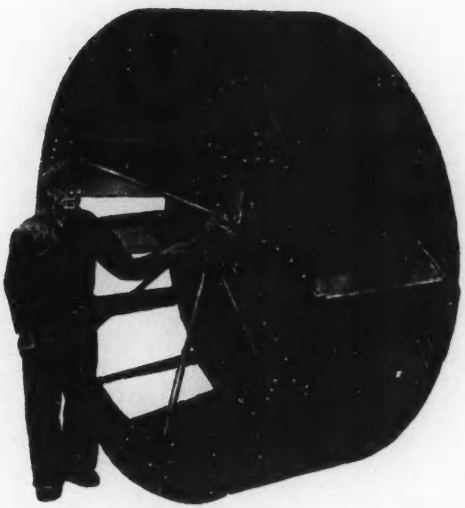

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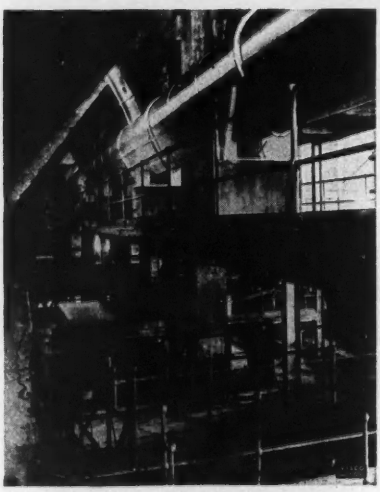

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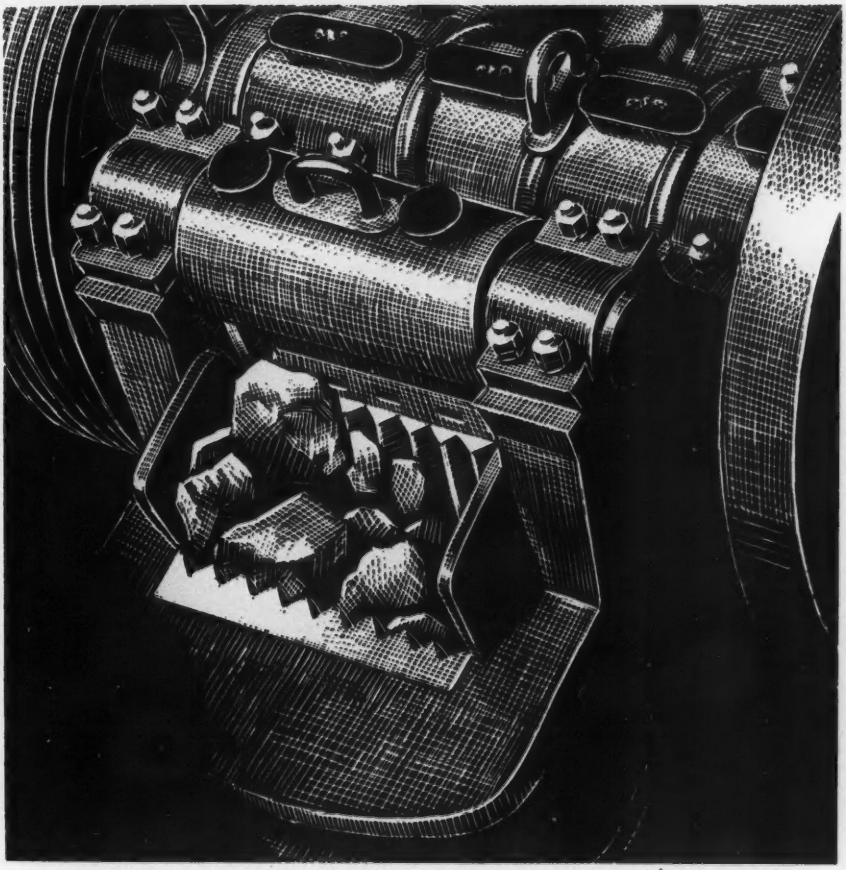

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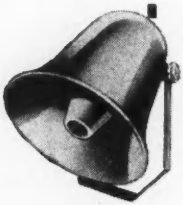

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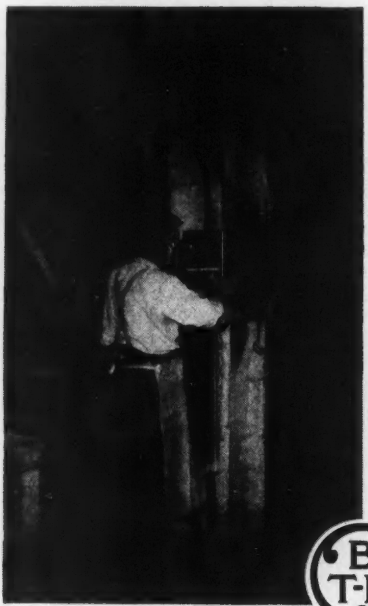

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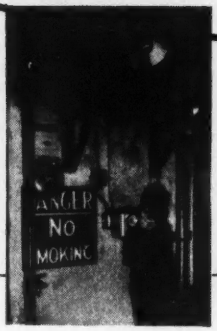

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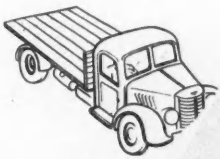

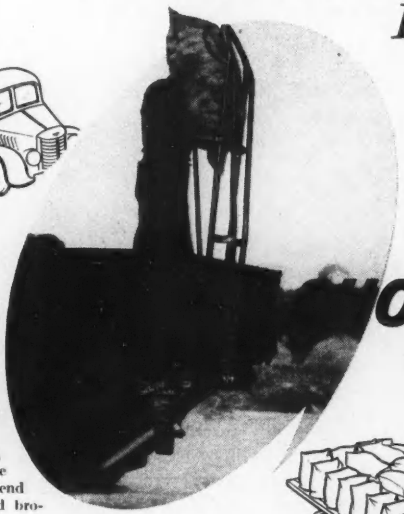

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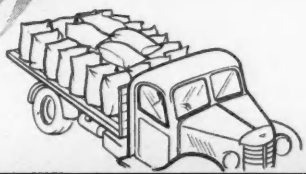

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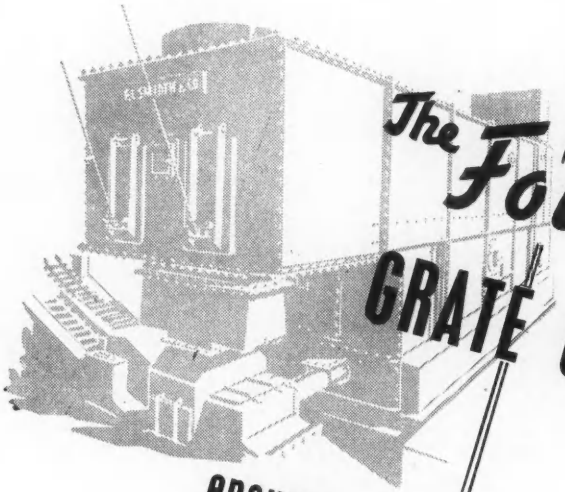

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PUBLISHED BY
CONCRETE PUBLICATIONS LIMITED
14 DARTMOUTH STREET, LONDON, S.W.1.

TELEPHONE: WHITEHALL 4581.
TELEGRAPHIC ADDRESS:
CONCRETIUS, PARL, LONDON.

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VOLUME XXVI. NUMBER 2 MARCH, 1953

Cement Burning in Rotary Kilns.

By P. T. S. MILLER, B.Sc.
(OF HENRY POOLEY, CONSULTING ENGINEERS).

A MODERN rotary kiln operating on the dry process can achieve a thermal efficiency of about 34 per cent. and a wet-process kiln about 27 per cent. The Lepol kiln has a thermal efficiency of about 40 per cent.; this seems the highest so far obtained, although some shaft kilns of modern design are reported to reach 47 per cent. with a standard fuel consumption of 13 per cent.

Chemical and Heat Reactions.

Fig. 1 shows, diagrammatically, a rotary kiln, and the temperature curve below shows five separate phases for the wet process and four for the dry. Reading from right to left:

(1). Drying. Here the material or slurry is heated from 20 deg. C. or air temperature to 100 deg. C., when the slurry water is driven off.

(2). Heating. This phase, which is also the start when the dry process is used, consists in heating the raw materials to about 850 deg. C., when the evolution of carbon dioxide from the calcium carbonate starts. There are, however, two endothermic reactions, namely, one at 402 deg. C. when carbon dioxide from magnesium carbonate is driven off, and another at about 500 deg. when combined water from the clay is freed. These two reactions require comparatively little heat.

(3). Calcining. Here most of the carbon dioxide combined as calcium carbonate is driven off, requiring a large amount of heat since the reaction is endothermic (756 B.Th.U. per pound of $CaCO_3$ is commonly assumed). During this phase most of the heat absorbed by the material is used to this end, so that the temperature rises much more slowly as can be seen by the shape of the curve.

(4). Sintering. During this phase the critical chemical reaction which forms the clinker takes place. If the material does not reach this phase, underburnt material results. This stage is accompanied by a marked exothermic reaction, which aids in the attainment of the clinkering temperature. The sudden release of

heat within the material (about 180 B.Th.U. per lb. of clinker) is sufficient to raise the temperature by about 100 deg. C. ignoring any heat from the flame; with flame the temperature rises from 1000 deg. C. to about 1250 deg. C. At this stage rapid chemical combination between the lime, silica, alumina, and iron oxide commences ; at about 1250 deg. C. onwards the iron and alumina content begins to fuse and aids further the combination. When the material has reached its maximum temperature of about 1400 deg. C., about 20 per cent. to 30 per cent. has been liquefied, depending to a large extent on the amount of iron and alumina present.

(5). Cooling. In the cooler the newly formed compounds crystallise from the molten and semi-molten state, and some glass, depending on the rate of cooling, is also formed. Except with the Fuller and similar types of cooler the burner has little control over this process, though it may have some effect on the final properties of the cement.

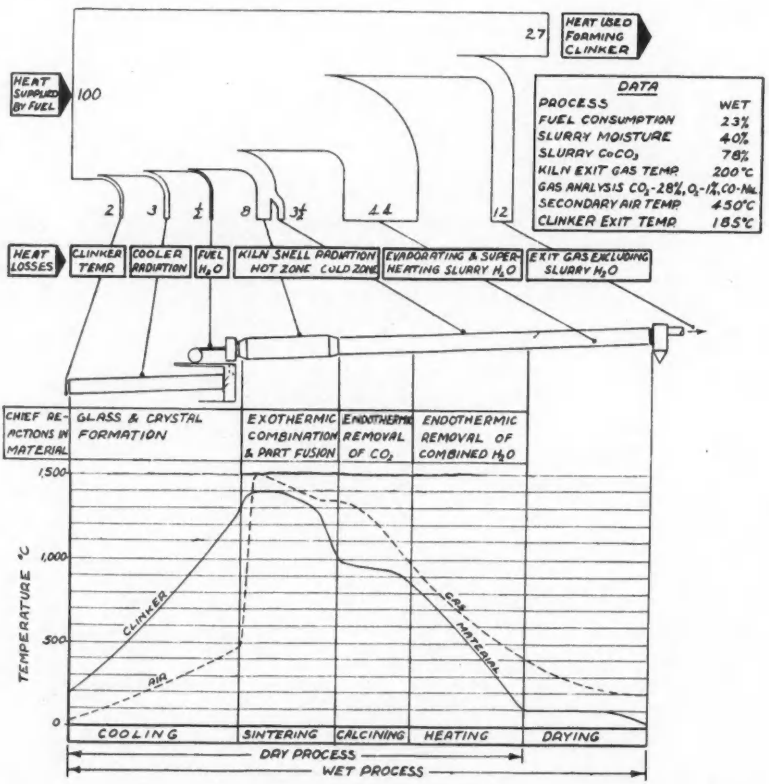


Fig. 1.—Heat Distribution and Temperature of Material and Gases for Wet-Process Kiln.

These phases are never clearly divided but merge one into the other; for example, chemical combination between the silica and calcium carbonate is known to start at as low a temperature as 800 deg. C. (*) but at a very slow rate. By taking samples from a kiln during operation it has been found that free lime persists even when the clinker has reached its maximum temperature, so that it is important that the material be given time to complete the combination of all the free lime.

On looking into a kiln the dark shadow of the "feed" can be seen, and on looking farther along the material a marked rise in temperature can be distinguished by a glow from the material. This sudden rise corresponds with the release of exothermic heat and the sharp rise in the temperature curve, and explains the speed with which a kiln can begin producing underburnt clinker. If, for some reason, the supply of heat should fall off, the clinkering starts farther along the kiln, until a point is reached where the material is not heated sufficiently to start the exothermic reaction; thus the process suffers a double loss of heat, and underburnt clinker results.

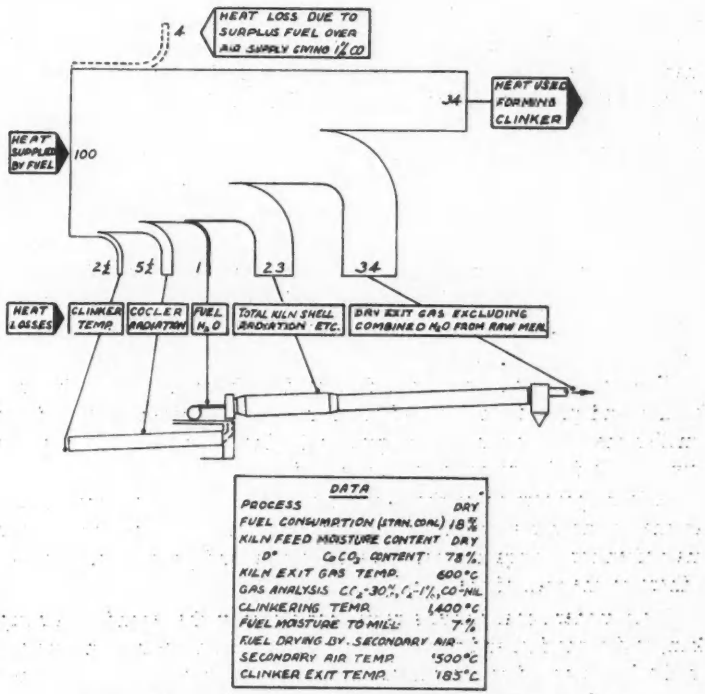


Fig. 2.—Heat Distribution in Dry-Process Kiln.

(*) Lea & Desch, "Chemistry of Cement and Concrete," 1935. p. 103.

The Flame.

Oil and gas are ideal fuels for rotary kilns as they possess, as a rule, constant calorific value and can be supplied at a very constant rate. They are also ashless, and do not alter the composition of the feed. With pulverised fuels the content of ash, volatile matter, and moisture varies, and consequently the calorific value alters depending on the source of supply. Where coal is received from two or more collieries a system of blending is a great advantage. Variable coal supply is one of the chief difficulties with which the burner has to contend.

The burning of cement is essentially a high-grade heat operation ; that is to say sufficient heat units are required at a high temperature. For clinkerisation to take place the material must be heated to about 1400 deg. C., and it has been estimated that the flame temperature using pulverised fuel reaches only about 100 deg. C. more than this temperature (*Fig.* 1). Most of the heat at high temperature is passed to the material by radiation, and the higher the flame temperature the greater the radiation.

Importance is attached to air turbulence, to an intimate mixture of fuel and air and to fine division of the particles of fuel, all of which tend to create rapid combustion and high flame temperatures and radiation. It should be noted that the flame radiation along the kiln to the colder regions is largely responsible for the low thermal performance of rotary kilns and a lack of this defect is responsible for the superior performance of Lepol and shaft kilns. This subject will be discussed further when the sources of heat loss are examined.

Recent experimental work by Mr. A. A. Orning on the combustion of coal particles under conditions similar to those in a flame seem to indicate that, while there is obviously an upper limit to the particle size of pulverised coal, there is no advantage in a large proportion of very fine material and that an optimum fineness probably exists for any particular coal. Normal residues in practice amount to 5 to 10 per cent. on a 100-mesh sieve and 20 to 30 per cent. on a 180-mesh sieve.

The volatiles contained in a fuel tend to burn first near the mouth of the burner, and provide intense radiation there. It is generally considered that the smaller the volatile content the greater the fineness required in grinding, and that low-volatile fuels are not so easily ignited.

A large proportion of the ash content of a fuel passes into the raw mixture at one or another stage in the kiln, and may prove to be a nuisance in that ash may often form rings if it has certain chemical and physical properties to make it adhere to the wall of the kiln.

Most modern coal pulverisers use hot air, from the secondary air supply to the kiln, to dry the fuel and to transport it into the kiln, so that any moisture present in the fuel supplied to the pulveriser is carried as vapour into the flame. Its effect on kiln performance is practically negligible as far as heat loss is concerned: a moisture content of 1 per cent. could be offset by reducing the slurry moisture in a wet-process kiln by 0·1 per cent. (*Figs.* 3 and 4). However, fuel with, say, 10 per cent. moisture may affect the flame temperature even though no latent heat is

required for the already vaporised water. The poor burning quality of moist coal is more likely to be due to poor grindability causing large particles or to choking of the mill rather than to a direct loss of sensible heat due to the moisture present.

Fuel, Air, and Feed.

These are the three factors which the burner has under his control; they are interdependent, and the less the variation the easier the task of the burner. For a given quantity of feed a corresponding quantity of air is required. Unless the volume of feed varies the air supply should not be changed. Wet-process kilns are inclined to suffer more from variable rates of feed in the burning zone due

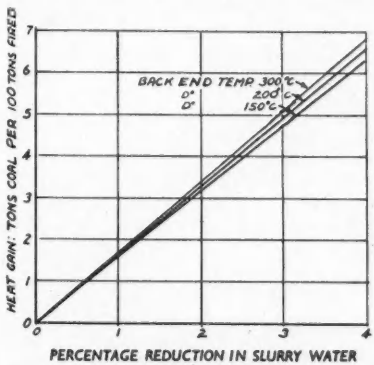


Fig. 3.—Heat Saved by Reduction of Water in Slurry.

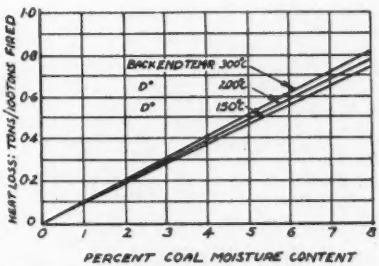


Fig. 4.—Heat Loss due to Moisture in Coal.

to holding up of the slurry while in the "puggy" stage. The control of the air supply can be carried out by means of damper adjustment, by a variable-speed induced-draught fan motor or by a variable-speed fan drive. Either of the two latter arrangements is preferred as being more positive and trouble free. Oil or gas can be supplied at a very constant rate, and normally they are of constant composition so that they give no cause for anxiety.

The rate of feeding a solid fuel depends largely on its moisture content, so that when a table or belt-feeder is used to supply the pulveriser a variation in moisture content can cause a large variation in the rate of feed. A constant-weight feeder is useful, but it is doubtful whether the expense is justified as variations can still occur due to moisture and variable calorific value.

The back-end or exit-gas temperature is a valuable indication of the variations in heat supply and, combined with visual observation of the position of the sintering zone with regard to the flame, provides the best indication of the state of the process. The clinker at its maximum temperature should be formed into the characteristic pellets or balls up to about $\frac{3}{4}$ in. or 1 in., depending on the nature of the raw material, and should appear to be slightly plastic due to the presence of fused products. Overburning can be detected by the formation of larger balls of material in snowball fashion at the lowest point of the feed; this phenomenon

is known as " balling." When a kiln starts to " ball " there is a danger of fusing the lining and the firebricks in the burning zone. These remarks are of a general nature and each kiln must be judged according to the raw materials and fuel used. In general, materials high in iron and alumina are easier to burn (that is, they will burn at a lower temperature) than those with a high silica content, but balling may start at too low a temperature causing large pieces of clinker to form. A better lining to the firebricks in the burning zone is often obtained with material high in iron content.

The feed to a kiln should be as constant as possible. It is an advantage to synchronise the feeder to the speed of rotation of the kiln so that the volume of feed to the kiln is reduced should it become necessary to reduce the speed when the amount of feed in the burning zone is too great to be properly burnt.

If, for any reason, an excess of feed is expected, or the supply of feed has been increased, it is wise to anticipate its arrival in the burning zone by increasing the fuel and air supply. Failure to do this results in underburnt clinker, or the speed of the kiln has to be reduced for a short time in order to " burn back."

Many kilns are fitted with a device for changing the position of the burning pipe in a longitudinal direction, and further variation in the position of the flame can be achieved by varying the velocity or quantity of primary air. A variation in the position of the flame will sometimes prevent the formation of clinker rings, or allow one ring to break up while a new one is formed in a different place. Normally the flame is directed slightly towards the material, but this should not be overdone or the clinker may be exposed to a reducing atmosphere which is supposed to have a deleterious effect on the clinker.

Fuel Economy.

Of the present cost of cement in Great Britain about 25 per cent. is accounted for by the cost of coal. *Fig.* 1 shows diagrammatically how the heat supplied to a wet-process kiln with a standard coal consumption of 23 per cent. is used. For the sake of clarity a simple kiln with an enlarged burning zone, a parallel cold zone, and a rotary cooler are shown. A kiln with an enlarged slurry end or slurry dryer would merely have a shorter drying zone.

The burner can do little to prevent loss of heat due to the lower temperature of the clinker at the exit end, except to ensure that the kiln hood and cooler sealring are not admitting cold air. A high secondary air temperature is important to ensure a high flame temperature. Radiation from the kiln and the shell of the cooler is inevitable and insulation is impracticable, so that no improvement can be made here.

The effect of moisture in coal can be greatly reduced by keeping the hot air supply to the pulveriser at as high a temperature as possible, consistent with safety.

Nearly one-and-two-thirds times the heat usefully used in forming clinker is used in evaporating the water in the slurry and superheating it to the exit-gas temperature. The way in which a reduction in the moisture content of the slurry can save fuel is shown in *Fig.* 3. This shows the calculated values. It is doubtful whether such a large saving would be achieved in practice ; it is more probable

that a reduction in the slurry-moisture would result in a compensating rise in the back-end temperature, with a slight overall saving. These curves are calculated for a 25 per cent. standard coal consumption and 40 per cent. slurry moisture.

By preventing large fluctuations in the fuel supply, the burner can keep a steady low back-end temperature, which is an aid to fuel economy.

The chief cause of wasting fuel from the burning platform is the supply of too much or too little air to burn the fuel completely. A pound of carbon burnt to form carbon monoxide gives off 70 per cent. less heat than if it is burnt to form carbon dioxide. Furthermore, *Fig.* 6 shows how the supply of too much fuel to the flame can actually reduce the heat given out.

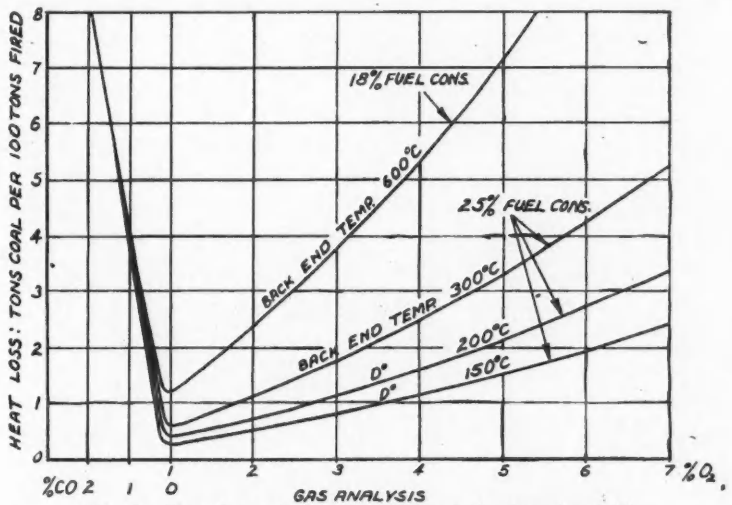


Fig. 5.—Heat Lost due to Variation of the Supply of Air.

It is common to keep the oxygen in the exit gases at about 1 per cent., which results in an excess air supply of about 5.5 per cent. The effect of varying the air supply above and below this value is shown in *Fig.* 5. Obviously it is better to use too much air than too little which leads to the formation of carbon monoxide. The advantage of keeping a low back-end temperature is also apparent. The curve showing loss of heat with a back-end temperature of 600 deg. C. relates to a dry-process kiln.

Automatic oxygen and carbon monoxide recorders are a great advantage in instantly showing when the best is not being obtained from the fuel. Incidentally the practice of reducing air and increasing coal supply in order to " box the heat in at the front of the kiln " when attempting to " burn back " is quite contrary to the principles of good combustion (see *Fig.* 6).

In *Fig.* 2 the relative heat loss for only 1 per cent. CO in the exit gases is shown at the top of the heat diagram. The high radiation loss of 23 per cent. shown in *Fig.* 2 compared with 11½ per cent. for the wet-process kiln shown in

Fig. 1, appears to be inconsistent but, per unit of clinker produced, the radiation loss is more comparable. Other things being equal, it is probable that a wet-process kiln would have a slightly higher radiation loss in practice. A more important point is the high loss due to the dry exit-gases. This is comparable in the wet-process with the large amount of heat expended removing water from the slurry. However, whereas in the wet process it is necessary to remove the slurry water, it is not, in a dry process, essential to heat large quantities of exit gas to 600 deg. C. or thereabouts. The reason for this great waste of heat, namely direct radiation from the hot to the cold zone, has already been referred to, and is also due to lack of close contact between the gases of combustion and the material. That this loss can be overcome has been shown in the Lepol kiln, and also in the shaft kiln.

The specific heat of air and clinker being nearly equal, it is safe to say that, given equal quantities of air and clinker, and with no losses, one pound of clinker could heat one pound of air to its own temperature. With a coal consumption of 25 per cent. the ratio of air to clinker is about 2·6 : 1, so that at best the secondary air to the flame can be heated to only, say, one-third of the clinkering

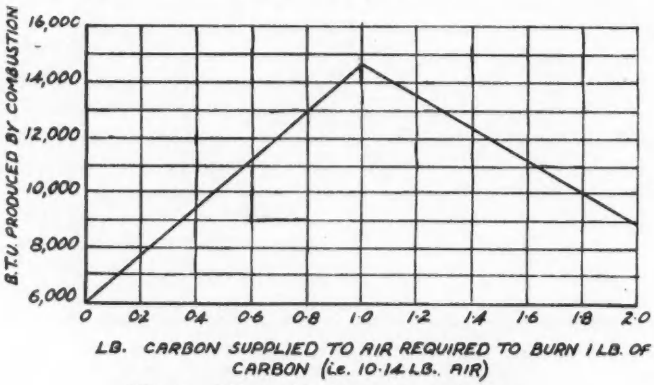


Fig. 6.—Effect of Incorrect Fuel Supply.

temperature. If, however, the fuel consumption is improved to 18 per cent. then the air-to-clinker ratio falls to about 1·9 : 1, so that a great improvement in the secondary-air temperature can be utilised to improve the flame temperature and thermal efficiency.

Quality.

The most obvious method of producing bad clinker is to underburn it. Curiously enough it has been found that overburning can lead to similar defects under some conditions.(*) The high temperatures involved lead to a re-formation or separation of free lime which, under favourable conditions, will re-combine but likewise may remain in the free state on cooling. The latter is more likely

(*) Bogue, "The Chemistry of Portland Cement," p. 166.

to be the case if the grains of lime have become relatively large. On the whole, however, overburning is not considered serious from the point of view of quality.

The presence of a reducing atmosphere or lack of sufficient air for the fuel has been said to have a deleterious effect on the cement. No apparent cause can be stated, although it is said that the cement is more difficult to grind and has a slower rate of strength development. A reducing atmosphere may cause reduction of ferric oxide to ferrous oxide in the clinker, and this may impart the generally unfavoured brownish colour, especially in the centre of the kernel, since the shell is re-oxidised on cooling. In any case no kiln should be operated with a reducing atmosphere since this implies presence of carbon monoxide in the exit gas.

Cement Production in Great Britain in 1952.

TOTAL deliveries of cement in Great Britain for the home and export markets have increased each year for the last five years, and during last year set up a new record. The production in the year 1952 for the home trade increased by over one million tons, an increase of 12·3 per cent. over that for the year 1951. The totals for the last three years are : 1950, 7,808,000 tons ; 1951, 8,145,000 tons ; 1952, 9,147,000 tons.

In June, 1952, the price of cement was reduced by 3*s.* a ton in most areas and by 2*s.* a ton in other areas. Two further reductions of 2*s.* 9*d.* and 3*s.* a ton for packed cement were made later in the year owing to reductions in the price of paper.

Exports during the year totalled 2,055,000 tons, which is an increase of 4 per cent. over those for the year 1951.

An increase of about 500,000 tons in the productive capacity of the industry will be available in 1953, and a still larger production is planned for 1954.

Conference on Particle-size Analysis.

THE Institute of Physics is arranging a conference on " The Physics of Particle Size Analysis " at the University of Nottingham from April 6 to 9, 1954. It is anticipated that the sessions will cover the fluid dynamics and the optics of particles and systems of particles, and also phenomena such as the aggregation and dispersion of particles in a fluid. Arrangements will be made also for a discussion on automatic methods of counting and sizing. The development of new instruments and their use will receive attention, particularly the comparison of different methods of particle-size analysis.

The Committee is prepared to consider offers of papers describing original work. The honorary secretary is Mr. R. L. Brown, at the Institute of Physics, 47 Belgrave Square, London, S.W.1.

Research on Cement.

THE following is abstracted from the report for the year 1951 of the Building Research Board, published by H.M. Stationery Office at a price of 4*s*. 6*d*.

Cement and Silicate Chemistry.

Since the original investigation of the system CaO-$2CaO{\cdot}SiO_2$-$5CaO{\cdot}3AL_2O_3$-$4CaO{\cdot}Al_2O_3{\cdot}Fe_2O_3$ demonstrated the general nature of the constitution of Portland cement, two main lines of investigation have been pursued and the atomic structure of the main cementing compounds has been studied with the object of explaining their reactivity. In the course of this work information has been accumulated indicating that many of the cement minerals have a variable composition. The work has been extended to include high-alumina cement and blastfurnace slags. During the year the structure of larnite (β $2CaO{\cdot}SiO_2$) has been fully worked out and a report describing the work is being published.

One method of studying the constitution of Portland cement is to attempt to separate out from cement clinker homogeneous preparations of the separate minerals. Owing to the small crystal size and the complexity of the intergrowths between different components such separations are difficult, but the work has been partially successful in that a combination of chemical and physical methods has made it possible to extract material in which the percentage of a given constituent is considerably enhanced. It then becomes possible to identify by X-ray methods the crystal character and in some cases the chemical composition of the mineral. In general, because of the many components present and because most of the minerals are of low crystal symmetry (giving weak and complicated X-ray powder spectra) such an assessment cannot be carried out on the untreated cement clinker.

The method of thermal analysis has been applied to a study of the solid solutions of dicalcium silicate ($2CaO{\cdot}SiO_2$) and tricalcium silicate ($3CaO{\cdot}SiO_2$). It has been confirmed that the latter mineral is present in cement in an impure form, probably containing lime, magnesia, and alumina in solid solution. Since the various polymorphic forms cannot be distinguished except by means of single crystal X-ray photographs, it has not yet been possible to identify the composition of the cement mineral with certainty.

Additions of High-magnesia Slags.

Results of crushing tests on three-year-old concrete cubes made with a cement containing an addition of slags from a dolomitic burden, and therefore containing a high percentage of magnesia, confirm the earlier conclusion that such cements are not subject to long-term expansion and disintegration, as might be expected if free crystalline MgO were present.

The Cement Industry in Mexico.

IT is estimated that the production of cement in Mexico in the year 1952 was 2,000,000 tons. The State of Guerrero has approved plans for the construction of a new cement works at a cost of 8,000,000 pesos.

The Portland Cement Industry in Spain.

PROGRESS DURING FIFTY YEARS.

THE number of "Cemento y Hormigon" for February 1952 is a special issue published to commemorate the fiftieth anniversary of the manufacture of Portland cement in Spain, and contains a wealth of information on the subject. Among the special contributions in this number is a review by Sr. Julian Rezola, managing director of a leading Spanish cement-making company, who has been associated with the industry during the whole of the past fifty years. The following abstract of Sr. Rezola's review is given by permission of the author and of "Cemento y Hormigon".

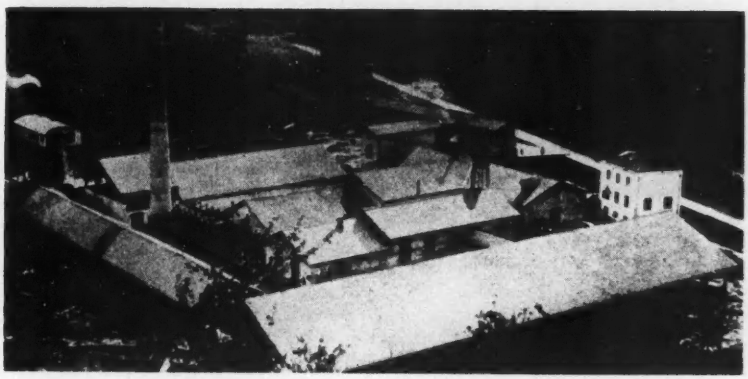


Fig. 1.—The Original Works at Añorga.

The cement industry in Spain has developed so greatly in the past fifty years that it now compares with that of any other country in the quality of the product and efficiency of production. The first cement factories were built in Spain at Tudela-Veguin in 1898, at Quinto in 1900, and at Rezola in 1901. The pioneer period of the industry (1898 to 1910) was followed by the period of consolidation (1910 to 1924), and then by a period of expansion and improvement (1925 to 1934), after which came a period of political and social unrest and finally the more recent period of development.

At the end of the last century, when intermittent vertical kilns were being replaced by continuous vertical kilns, Hanenschild produced a cylindrical vertical kiln with a cooling zone and gas recovery. This was followed by the Timm kiln with forced draught, and also with the important feature that it used coal, coke, or broken anthracite, instead of the large furnace-coal needed for the first continuous furnaces. The rotary kiln was being introduced, especially in America. These kilns had natural draught, and were about 5 ft. diameter by 35 ft. long. Ball mills and tube mills appeared.

Fig. 2.—The Present Works at Añorga.

The early Spanish factories employed machinery made in Germany. The differences between an early and a modern works are shown by *Figs.* 1 and 2. Each part of the early works was a separate building. In those days gangs of men fed the crushers, loaded the briquettes on to carts, and took them to the tunnel dryer and thence to the kilns. The blocks of clinkerised material were broken by striking them with bars, and the men worked in an atmosphere of dust, to which a large contribution was made by avalanches of non-calcined material. The present works (*Fig.* 2) occupies the same area as the old, but has a capacity of 200,000 tons a year compared with 24,000 tons for the old works. The first rotary kilns in Spain were 6 ft. 6 in. diameter by 66 ft. long and produced about 40 tons a day. Because of the high fuel consumption the works were, whenever possible, installed in mining regions, as at Tudela-Veguin.

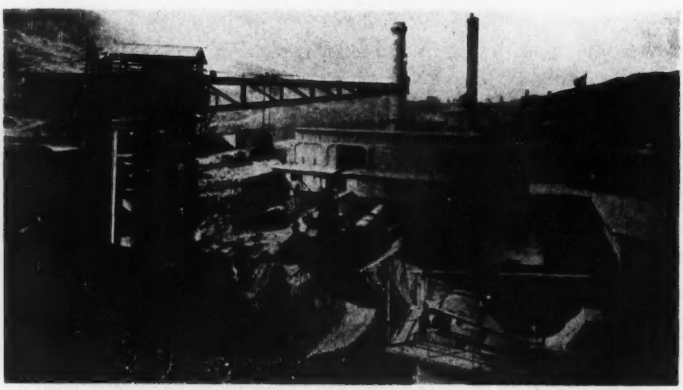
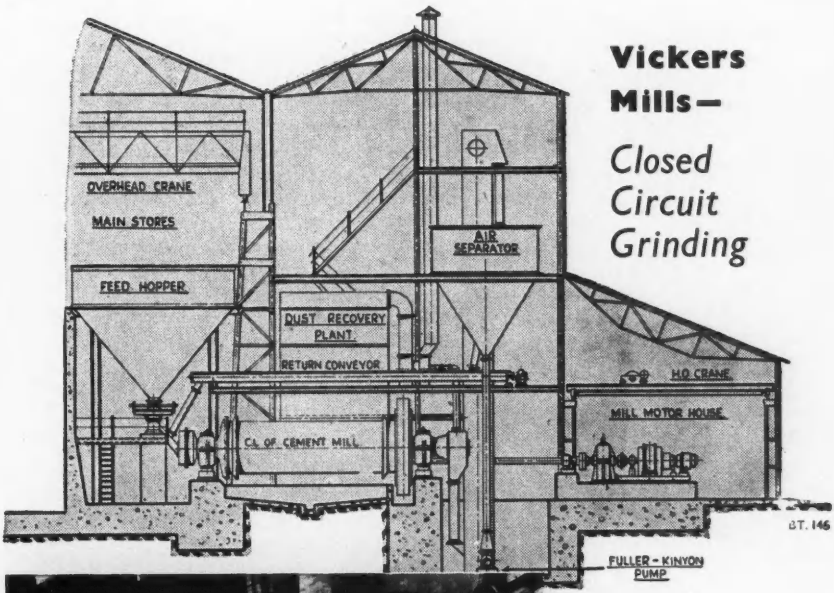


Fig. 3.—The Moncada Works of the Asland Company after Installation of Third Rotary Kiln.



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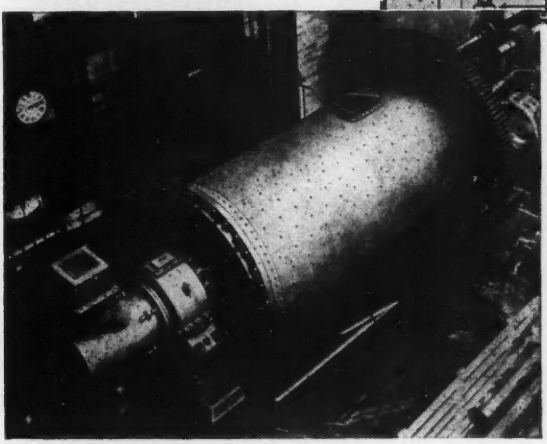

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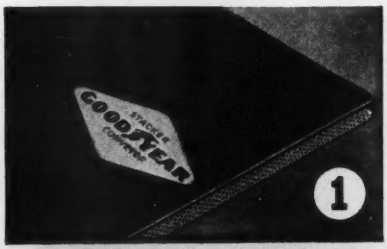

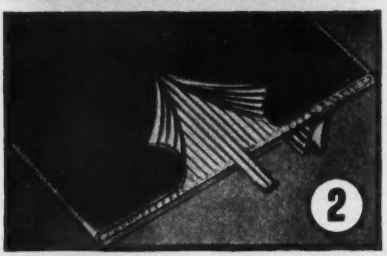

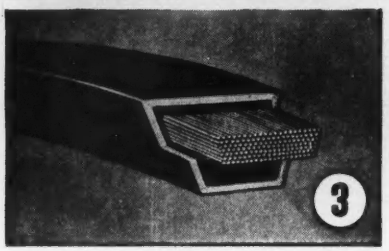

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In the works at Añorga, away from the mining zone, Timm kilns were installed. The rotary kilns at the Asturias works had the special feature that sludge could be used in them as fuel. The Asland Company set up its first works at Castellar d'En Huch (Barcelona), and in 1905 the Cangrejo works was erected at Olazagutia (Navarre) with three rotary kilns. The works of Castellar d'En Huch had for the greater part American machinery by Allis-Chalmers, with three rotary kilns, the largest then in existence. Lignite was used as fuel, thus anticipating by many years what later became a necessity for many works. The works at Castellar embodied the novelty of using hydraulic power with turbines of the Pelton type. In 1910 the productive capacity in Spain reached 174,000 tons, the whole of which was made by the dry process, and this brought to a close what may be termed the pioneer period. At the Añorga works in 1906 the power consumption was 85 kWh. per ton, the coal consumption was 24 per cent., and it took 16 man-hours to

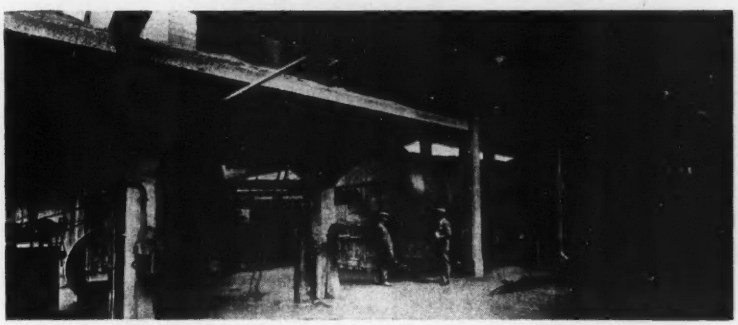

Fig. 4.—Dry-process Kiln, Capacity 280 tons a Day, at the Moncada Works.

produce one ton of cement. The fineness was 12 to 15 per cent. on a sieve with 900 meshes per square centimetre and 20 to 25 per cent. on a sieve with 4,900 meshes per square centimetre.

From 1910 onwards new factories were installed and the existing works enlarged. The Yeles-Esquivas works was built in 1910-1913, and the motive power comprised four gas engines. It worked irregularly up to 1916, when it was electrified. The Iberia works was built, and had the first rotary kiln in Spain on the wet process; it was 150 ft. long and had an output of 95 tons a day. The Fradera works, also on the wet process, had a kiln with an output of 90 tons a day. Four works were built at Bilboa, and one each at Madrid, Valencia, Malaga, Moron de la Frontera, and Toral de los Vados. In 1923 there were twenty cement companies in Spain. This period witnessed the installation of twelve rotary kilns on the wet process, with an output of 423,000 tons a year. The kilns generally had an output of 110 to 120 tons per day, and the longest was 204 ft. Ten dry-process kilns were installed with a capacity of 456,000 tons a year; generally these kilns had an output of 130 tons a day, the largest producing 280 tons. Twenty-one

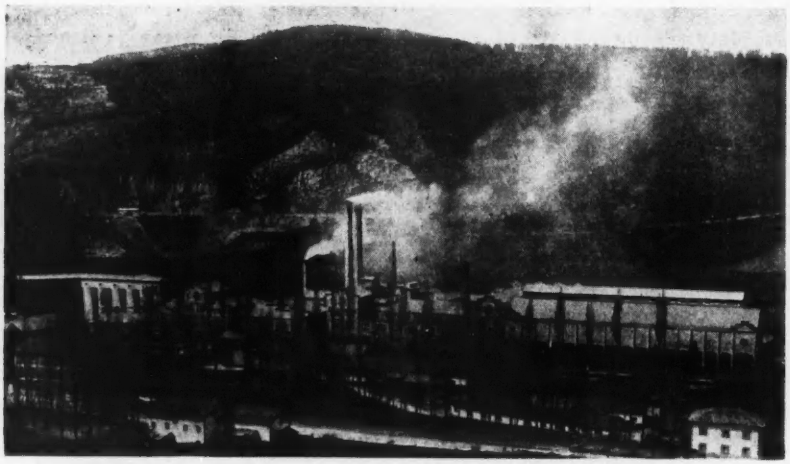

Fig. 5.—The Olazagutia Works.

vertical kilns were built with a capacity of 197,400 tons a year. Productive capacity increased during the period to 1,076,400 tons a year, of which about two-thirds was made by the dry process.

In this period compound mills were introduced, using steel balls instead of flint, and a fineness of 8 per cent. on a sieve with 4,900 meshes per square centimetre was obtained. Transport of materials was mechanised, longer rotary kilns improved the utilisation of heat from the gases, and coal consumption, while remaining very high, was reduced in both the wet and dry processes. Vertical kilns became more and more efficient.

About the year 1925 the industry began to develop in an extraordinary fashion, and the appearance of the Lepol kiln in 1928 revolutionised the rotary kiln.

Fig. 6.—The Quarry at Olazagutia, 1915.

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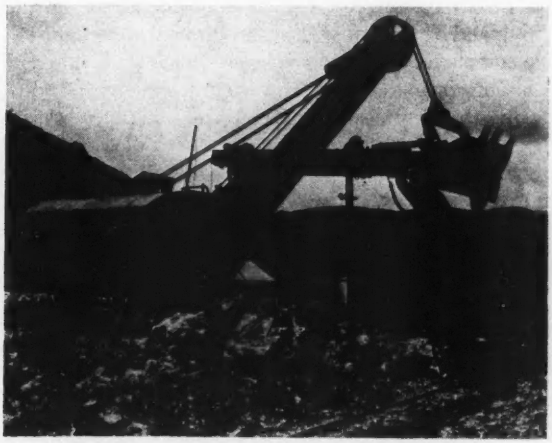

Fig. 7.—The Quarry at Olazagutia, 1952.

The first Lepol kilns were installed by the Rezola, Hispania, and Asland Companies. The Cangrejo works installed calcinators, and at Fradera was installed a kiln 340 ft. long.

At Añorga in 1929 the whole of the works was reorganised and new plant installed. New factories were built at Cordoba and Morata de Jalon. Six new concerns were established with factories at Barcelona (1), Zarogoza (2), Alicante (1), Santander (1), and Guipuzcoa (1). Thirteen wet-process kilns had a capacity of 711,500 tons a year and seven dry-process kilns had a capacity of 432,000 tons a year. Vertical kilns had a capacity of about 188,000 tons a year. The wet-process kilns generally had a capacity of from 100 to 300 tons per day, and the

Fig. 8—The Vallcarca Works of Cementos Fradera, S.A.

dry-process kilns from 150 to 270 tons. Apart from the use of forced draught in the kilns, the outstanding feature of this period was the mechanisation of quarries, the use of large compound mills and the improvement in fineness, the use of compressed air for transporting cement, and the introduction of automatic packing machines. As in other European countries, the wet process has been preferred in Spain, although the dry process produces cement of very high quality.

The recent years have been a period of technical development. The renewal of the equipment is proceeding apace. The centres of cement production have shifted, and the new works are close to the areas of consumption and near hydro-electric power stations. The capacity has increased since 1941 by 367,000 tons a year. There are now in course of construction six wet-process kilns and four dry-process kilns (three of them Lepol) with annual capacities of 520,000 and 250,000 tons by the respective processes. The largest dry-process kiln is at the Añorga works and has a capacity of 270 tons a day. The largest wet-process kiln is at the Olazagutia works ; it is 480 ft. long including the pre-heater and has a capacity of 400 tons a day. One of the new works will make slag-cement, and a new works near Venta de Banos is designed to operate without hoists or conveyors and will be the most economical in labour of all Spanish cement works. The coal available in Spain is of inferior quality, but the aim is to reduce the coal consumption to 1,000 to 1,100 kilo calories by the dry process and 1,400 to 1,500 kilo calories by the wet process.

An Improved Lepol Kiln.

As a first step towards the complete conversion from the wet process to the dry process, Skanska Cementaktiebolaget, of Hellekis, Sweden, has recently put into operation a " double-pass " Lepol kiln supplied by the Polysius organisation. The results obtained are as follows : Guaranteed output, 500 tons per day ; actual output, 552 tons per day. Coal consumption, including coal required for drying the coal, 820,000 calories per ton ; net coal consumption, 810,000 calories per ton. This corresponds to 11·5 per cent. standard coal by weight of clinker produced. Four kilns of this new type are now in operation.

The Cement Industry in Chile.

COMPANIA de Cemento Chilea, S.A., is erecting a cement plant with an estimated capacity of 250 tons daily, which is expected to be completed by the beginning of 1954. The capital of this company is forty million soles, and is owned by Peruvians.

New Cement Works in Spain.

A NEW cement works, with an annual capacity of 25,000 tons, started production in October, 1952, at Alcala de Rio, Seville.

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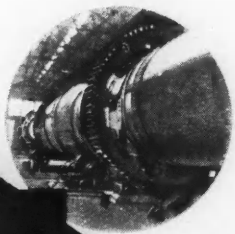

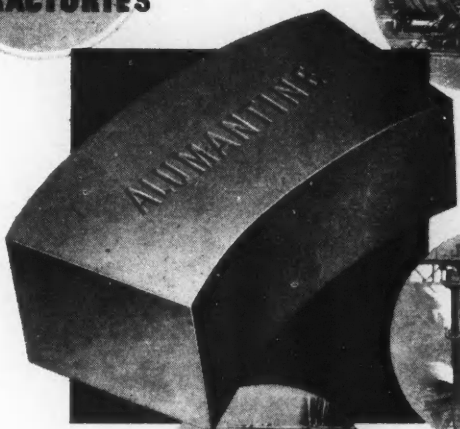

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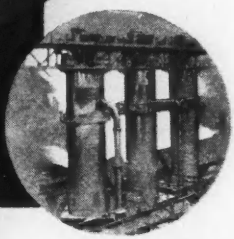

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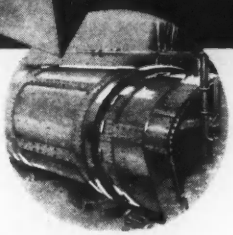

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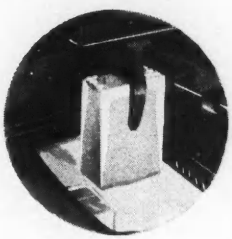

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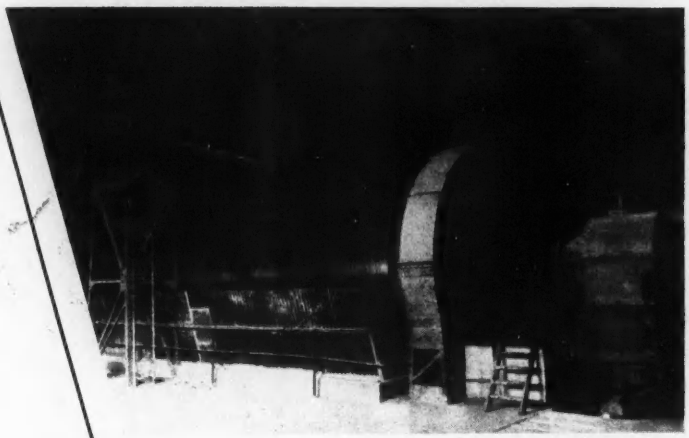

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Printed in Great Britain by CORNWALL PRESS LTD., 1-6, Paris Garden, Stamford Street, London, S.E.1.
Published by CONCRETE PUBLICATIONS, LTD., 14, Dartmouth Street, London, S.W.1, England.